



# Products & Resources

**N**ASA ESE produces and sponsors a wide-ranging suite of Earth system science education products for elementary through post secondary instruction and informal education. ESE education materials are designed to support standards-based education (including science, mathematics, geography and technology standards) and to supplement existing curricula.

The ESE education resources listed here have all passed an independent peer review. The review includes panels of educators and scientists, who assess learning resources based on their scientific accuracy and educational value. The purpose of the reviews is to help ensure that education materials distributed by NASA are of high quality and meet rigorous education standards. For more information about the review, visit: [earth.nasa.gov/education/esereview](http://earth.nasa.gov/education/esereview).

Most of these materials are available over the Internet. Many are also available for free at NASA Educator Resource Centers ([spacelink.nasa.gov/ercn](http://spacelink.nasa.gov/ercn)) or for purchase from NASA's Central Operation of Resources for Educators ([core.nasa.gov](http://core.nasa.gov)), which distributes materials to teachers, nationally and internationally, for a shipping and handling charge.

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## Elementary & Secondary

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## Classroom/Curriculum Materials

### ELEMENTARY

#### The Adventures of Amelia the Pigeon

<http://imagers.gsfc.nasa.gov/amelia/index.html>

This interactive adventure engages children in a story-based scenario that emphasizes concepts of remote sensing and how NASA scientists use satellite imagery to better understand the Earth's environmental changes. It introduces students to Earth science concepts, beginning with classifying objects in satellite images by shape, color and texture, building a foundation for interpreting and under-

standing remote sensing. The story is set in New York City, chosen for its size, diversity and the visibility of prominent features in satellite imagery. Lesson plans to accompany the adventure are in development.

**Recommended for: children ages 5–10.**

### **The Adventures of Echo the Bat**

<http://imagers.gsfc.nasa.gov/k-4/index.html>

<http://catalog.core.nasa.gov/core.nsf/item/300.1-06P>

This picture book of Echo the Bat is accompanied by a set of activities that reinforce four basic themes or concepts fundamental to the interpretation of satellite imagery: perspective, shape and pattern, color, and texture. Activities and activity sheets are also provided on a companion Web site: <http://imagers.gsfc.nasa.gov/k-4>.

**Recommended for: children ages 5–10.**

### **The Air We Breathe**

Available spring 2004 from NASA CORE at:

<http://core.nasa.gov>

Children entering the classroom have different levels of experiences. The picture book *The Air We Breathe* is designed to provide a common level of knowledge about Earth's atmosphere among students, and a foundation from which the teacher may launch a study of the atmosphere's composition and its importance to life.

**Recommended for: K–4.**

### **Climate Change Presentation Kit, 1999**

<http://www.epa.gov/enviroed/globalclimate.html>

The Climate Change Presentation Kit is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation and interactive activities that are designed to interest audiences of all levels. Order this free CD-ROM at the Web site provided.

**Recommended for: elementary–college educators, informal educators.**

### **Earth Systems Connections**

<http://www.ias.sdsmt.edu/esc>

Earth Systems Connections (ESC) is an elementary science, mathematics and technology curriculum that consists of multifaceted lessons organized into seven learning modules. Over 100 activities are contained within the ESC lessons. Each activity has been designed to develop in students a rich sense of how the Earth operates as one interconnected system. Visit the ESC Web site to access sample lessons from the curriculum. **Recommended for: K–5.**

### **Earth Update**

<http://earth.rice.edu/connected/earthupdate.html>

<http://core.nasa.gov>

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. Today's data can be downloaded from the Internet with a single click. Each "sphere" (atmosphere, biosphere, cryosphere, geosphere and hydrosphere) can be run separately or as the linked *Earth Update*. Each sphere includes the sections: What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?) and How (How do we study the geosphere?). The CD includes classroom activities aligned with national science, math and geography standards.

**Recommended for: K–12 and informal education.**

### **Everyday Classroom Tools**

<http://bea-www.harvard.edu/ECT>

The major theme explored in this curriculum is the pattern of change on planet Earth as it relates to the Sun. So many different subjects can be usefully mapped to this set of investigations of the world around us that it gives educators an opportunity to build upon an inquiry framework with their own related and connected ideas from different disciplines.

**Recommended for: grades K–6.**

### **Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-2002-12-HQ**

<http://spacelink.nasa.gov/products/ExploringEarth>.

*From Space*

<http://catalog.core.nasa.gov/core.nsf/item/300.1-36P>

Space Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth's orbit. This resource can enhance students' studies of Earth and space science, geography, social studies, mathematics, and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle.

**Recommended for: grades 3–12.**

### **From a Distance: An Introduction to Remote Sensing/GIS/GPS**

<http://education.ssc.nasa.gov/ltp>

This Web site includes lesson plans on remote sensing for grades K–3, 4–8 and 9–12, and links to related education resources. **Recommended for: K–12.**

**Glacier Power**

<http://www.asf.alaska.edu:2222>

<http://catalog.core.nasa.gov/core.nsf/item/400.0-89>

Published in 1997, *Glacier Power* was developed in cooperation with NASA by the Alaska Synthetic Aperture Radar Facility (ASF) at the University of Alaska, Fairbanks and in cooperation with the Fairbanks North Star Borough School District and the University of Alaska Fairbanks, School of Education. The guide includes information on glaciers and their importance to climate studies; lesson plans; student review exercises, activities and projects; and resources such as glacier imagery, satellite imagery, illustrations, diagrams and more. Available online at the Web site provided or on CD-ROM from NASA CORE.

**Recommended for: grades 3–5.**

**GLOBE Program Learning Resources**

<http://www.globe.gov>

K–12 students from all over the world are participating in the GLOBE program by taking environmental measurements at their schools and sharing their data via the Internet. NASA scientists use GLOBE data in their research and provide feedback to the students. GLOBE student observations and measurements cover the following areas: atmosphere/climate, hydrology, land cover/biology, soils and phenology.

GLOBE learning resources are distributed through teacher training workshops. They can also be freely downloaded from the GLOBE Web site or ordered from NASA CORE (<http://core.nasa.gov>):

- **GLOBE Earth System Science Poster and Activity Guide**—The poster represents visual data collected from satellites, ground based observations, and model predications representing solar energy, average temperature, cloud cover, precipitation, soil moisture and vegetation over a 12 month period in 1987.
- **GLOBE Protocol Videos: Atmosphere, Hydrology, Land and Soil**—These videos were created for teachers trained in GLOBE protocols at a GLOBE Workshop to use as a review, in addition to the *Teachers Guide*, before teaching the protocols.
- **GLOBE Videos: Overview, Water Transparency, and Earth as a System**—CD-ROM with sample videos about the GLOBE Program.
- **GLOBE Teachers' Guide**—This guide includes separate chapters on measurement areas (for example, Soils or Earth as a System), data sheets, and lab and field guides for the different measurements.

**Mission Geography**

<http://missiongeography.org>

<http://catalog.core.nasa.gov/core.nsf/item/400.1-37>

Mission Geography curriculum support materials link the content, skills and perspectives of *Geography for Life: The National Geography Standards* with NASA missions, research and science. Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. **Recommended for: K–12.**

**NASAexplores**

<http://nasaexplores.com>

NASAexplores provides free weekly K–12 educational articles and lessons on current NASA projects. While many articles focus on aerospace technology and human exploration and development of space, several Earth science articles and lessons appear, such as *Mapping the Earth from Space, I am a Sensor, Volcanoes from the Sky, Relief Maps, Making a Topographic Map, Thickness of the Atmosphere* and many others. **Recommended for: K–12.**

**NASA SCI Files™**

<http://scifiles.larc.nasa.gov>

The NASA SCI Files™ distance learning series introduces students in grades 3–5 to NASA and integrates mathematics, science and technology through the use of Problem-Based Learning (PBL), scientific inquiry, and the scientific method. The programs can be viewed and videotaped at no cost on PBS-member TV stations and via satellite broadcast. Episodes can also be viewed for free on the Internet via NASA's Learning Technologies channel: <http://quest.arc.nasa.gov/events/sci/index.html> and Knowitall.org at: [http://www.knowitall.org/nasa/html\\_wm/scifiles.html](http://www.knowitall.org/nasa/html_wm/scifiles.html).

You can also contact your local NASA Educator Resource Center (<http://education.nasa.gov/erc>) for a video copy or purchase an episode on videotape from NASA CORE at <http://core.nasa.gov>. The following are recent Earth science-related episodes of the NASA SCI Files™:

- **The Case of the Mysterious Red Light**—Have you ever seen an unusually red sunrise or sunset and wondered why? That's exactly what happens in this episode as the tree house detectives accept the challenge of trying to find the source of the red light (<http://quest.arc.nasa.gov/events/sci/2001/index.html>).
- **The Case of the Shakey Quake**—The tree house detectives are troubled by a strange tremor in the area, and they decide that they need to investigate earthquakes. Join the tree house detectives as they delve into geography, geology and plate tectonics to discover why they're "all shook up" (<http://quest.arc.nasa.gov/events/sci/2002/index.html>).

- **The Case of the Phenomenal Weather**—Join the tree house detectives as they plan a trip to Florida and encounter problems in trying to predict the weather. Learn about violent storms, such as hurricanes and tornadoes, weather fronts, global wind patterns and climates (<http://quest.arc.nasa.gov/events/sci/2001/index.html>).

### **Our Mission to Planet Earth: A Guide to Teaching Earth System Science, 1994**

<http://spacelink.nasa.gov/products/Our.Mission.to.Planet.Earth>

The primary goal of this guide is for children to become familiar with the concept of cycles and to learn that some human activities can cause changes in their environment. **Recommended for: grades K–3.**

### **The Potential Consequences of Climate Variability and Change**

<http://www.strategies.org/CLASS.html#Climate>

The potential impacts of climate variability and change provide the context for these inquiry-based activities. The modules include climate change overview activities for grades 1–4 and 5–12, as well as modules that examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health and water. **Recommended for: grades 1–12.**

### **Space Place**

<http://spaceplace.jpl.nasa.gov>

Fun activities for elementary–middle school children to do and make, while they learn about space and Earth science, and the technology that enables science. The “Teachers Corner” on the Web site contains curriculum supplements originally published in the ITEAS’ *Technology Teacher* magazine, including:

- **Keeping Nine Eyes on the Weather**—Build and demonstrate a simple working model of an Earth-orbiting instrument that scientists are using to study the atmosphere and pollutants that could be contributing to global warming.
- **Mapping the Watery Hills and Dales**—Learn how the Global Positioning System (GPS) satellites work. Find out how the TOPEX and Jason-1 satellites use GPS data in making very precise topological maps of the oceans.

### **Students’ Cloud Observations Online (S’COOL)**

<http://scool.larc.nasa.gov>

S’COOL is a real-time, collaborative science experiment that elementary through secondary students conduct with NASA scientists. Participants make ground truth observa-

tions of clouds for comparison with satellite data. These observations help NASA scientists validate the measurements from NASA’s CERES satellite instrument (Clouds and Earth’s Radiant Energy System). The following S’COOL educational resources are available to support the program:

- **Cloud Identification Chart** ([http://asd-www.larc.nasa.gov/SCOOL/Cloud\\_ID.html](http://asd-www.larc.nasa.gov/SCOOL/Cloud_ID.html))—Shows examples of different cloud types and classification, identifies cloud observation basics and information on how clouds were named, and provides an activity on how to make a cloud in a bottle. **Recommended for grades 3–8.**
- **S’COOL Tutorial** (<http://asd-www.larc.nasa.gov/SCOOL/tutorial/scool.html>)—Covers the following: determining satellite overpass time, observing cloud properties, transmitting results to NASA and comparing results with satellite-retrieved properties. **Recommended for grades 3–8.**
- **Student and Teacher Bookmarks** (<http://asd-www.larc.nasa.gov/SCOOL/bookmarks.html>)— Provide basic information about the importance of ground truth measurements for investigative science and the formation of clouds. **Recommended for grades 3–8.**
- **S’COOL Poster and Brochure** ([http://asd-www.larc.nasa.gov/SCOOL/post\\_broch.html](http://asd-www.larc.nasa.gov/SCOOL/post_broch.html))— Provide photos of different cloud types, and information describing the program and how to participate. **Recommended for: grades 3–12.**
- **S’COOL Web Site** (<http://scool.larc.nasa.gov>)— Provides information on the project and how to participate, as well as classroom materials and resources. **Recommended for: grades 3–12.**

### **Understanding the Biosphere from the Top Down**

[http://geo.arc.nasa.gov/sge/jskiles/top-down/intro\\_product/title-page.html](http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html)

Published in 1996, the 22 lessons in this package focus on studying the biosphere from space to teach students about the Earth system. **Recommended for: grades 4–12.**

### **Virtual Vacationland**

<http://www.bigelow.org/virtual>

The site includes over 40 hands-on activities on the following science topics: land topography, ocean bathymetry, coastal tides, ocean buoy data, ocean temperature, weather and climate, and watersheds and rivers. Each topic has a preview page that summarizes the material. Each topic also has 2 to 5 detail pages, which show where to access online data related to the topic and what the data mean.

**Recommended for: elementary–secondary.**



**Windows to the Universe**

<http://www.windows.ucar.edu>

*Windows to the Universe* brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities. Three levels of content are provided: students (K–12 through undergraduate), teachers and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games and data that brings science to life for students, teachers and the interested user. **Recommended for: K–12, informal education.**

**MIDDLE SCHOOL****The Adventures of Echo the Bat**

<http://imagers.gsfc.nasa.gov>

This interactive Web site allows students to follow Echo the Bat as he migrates through Arizona. The adventure offers a directed and investigative approach to how land features look from space, what the colors mean in a Landsat image, and an introduction to identifying habitats in a false color Landsat image. The site is supported with a teacher's guide that includes the following units: Understanding Light, Remote Sensing and Biodiversity. **Recommended for: grades 5–8.**

**Alaska: A Bird's Eye View**

<http://www.uaf.edu/asgp/k12>

In this Web-based, interactive story, Tutangiaq (Too-tang-geye-ack—nicknamed "2T"), a Canada goose, flies across Alaska looking for his family. As he flies, he tells children about the fascinating 49th state. Children learn how Alaska was purchased from the Russians and other facts about the state. They can also compare the size of Alaska to other states. 2T takes a flight across the volcanic chain in Alaska and helps students to interactively explore how scientists monitor volcanoes from satellite images in near-real time. At the coast, the bird also meets his walrus friend who shows him how the sea ice edge has receded and adversely affected marine life. Finally, 2T arrives in Fairbanks where children use satellite imagery to help 2T find and unite with his family. **Recommended for: grades 5–8.**

**Event-Based Science (EBS): Remote-Sensing Activities and other Modules**

<http://www.mcps.k12.md.us/departments/eventscience/rs.index.html>

These activities enable middle school students to use NASA remote-sensing data as they tackle real-world problems and tasks. The remote-sensing activities enhance the

following EBS modules: *Blight!*, *Earthquake!*, *Fire!*, *Flood!*, *Hurricane!*, *Oil Spill!* and *Volcano!* **Recommended for: grades 5–8.**

**NASA CONNECT™**

<http://connect.larc.nasa.gov>

NASA CONNECT™ is a series of free, 30-minute, standards-based instructional distance learning programs for students in grades 5–8. Each program is accompanied by an educators' guide describing a hands-on classroom activity, and a Web-based component that reinforces the learning objectives and extends the lesson into a technology-rich environment. The following Earth science-related episodes are available from the NASA CONNECT™ Web site, or can be ordered on videotape from NASA CORE at <http://core.nasa.gov>.

- **Data Analysis and Measurement: Ahead, Above the Clouds**—Students learn about hurricanes and how meteorologists, weather officers, and NASA researchers use measurement and data analysis to predict severe weather such as hurricanes ([http://connect.larc.nasa.gov/programs/2000-2001/ahead\\_clouds.html](http://connect.larc.nasa.gov/programs/2000-2001/ahead_clouds.html)).

**Signals of Spring**

<http://www.signalsofspring.net>

Signals of Spring engages students, working in groups, to use Earth satellite imagery to track and explain animal movement. Students conduct investigations of land and marine animals; bald eagles, sea turtles and red-tailed hawks are a few of the animals tracked in real-time. The program is inquiry-based and includes lessons, classroom activities, color and BW transparencies and special interactive, online GIS and 3-D maps and visualizations of animals and their migrations. **Recommended for: grades 6–8.**

**SkyMath: Mathematics for a Blue Planet**

<http://www.unidata.ucar.edu/staff/blynds/Skymath.html>

The University Corporation for Atmospheric Research (UCAR) developed *SkyMath*, a set of middle school mathematics modules incorporating weather data. *SkyMath* requires teachers and students to acquire and use current environmental and real-time weather data in ways that embrace the dynamic and uncertain natures of these data, in order to promote the teaching and learning of significant mathematics, consistent with the standards set by the National Council of Teachers of Mathematics. The *SkyMath* modules may be freely downloaded from the Internet. **Recommended for: grades 5–8.**

**Space Place**

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**Visit to an Ocean Planet**

<http://topex-www.jpl.nasa.gov/education/cdrom.html>

<http://catalog.core.nasa.gov/core.nsf/item/400.0-92>

This interactive, educational CD-ROM reveals the importance of our oceans to global climate and life. It allows users to explore the Gulf of Mexico with satellite data, investigate the 1997–98 El Niño, discover “what’s up” with Earth-orbiting satellites, and learn about the research activities of real life oceanographers. The curriculum background materials are arranged in the context of widely accepted teaching themes. The CD-ROM also highlights results from NASA’s TOPEX/POSEIDON satellite. Available from NASA CORE on CD-ROM or downloaded as PDF files from the TOPEX Web site provided.

**Recommended for: middle school.**

**MIDDLE-HIGH SCHOOL****Antarctic Expeditions: Ozone**

<http://www.planearthsci.com>

In this adventure, students are “hired” to determine if the size of the Antarctic ozone hole is increasing. They set sail on the Research Vessel Glomar, this time in Antarctica, where they embark on their own investigation following the scientific method by testing a given hypothesis. To assist them, satellite images of ozone concentration and instructional movies are located onboard the ship.

**Recommended for: middle–high school.**

**At Work in the Oceans**

<http://catalog.core.nasa.gov/core.nsf/item/400.1-45>

*At Work in the Oceans* is a CD-ROM that includes material created for the 1999 and 2000 field seasons of the Sustainable Seas Expeditions. The following curriculum units are included: Monitoring a Habitat, Tools for Exploring the Ocean and Oceanography Careers. They feature video clips, Web chat questions and answers, labs, activities and related resources materials. The curriculum units have been mapped to National Science Education Standards, as well as California, Texas and Florida science standards. **Recommended for: middle–high school.**

**Atlas of the Ocean: The Deep Frontier Teacher’s Guide**

<http://catalog.core.nasa.gov/core.nsf/item/300.1-28P>

This 30-page guide includes classroom activities that feature content taken from National Geographic’s *Atlas of the Ocean: The Deep Frontier*. Subjects include undersea hot spots, underwater archaeology, bioluminescence, coral reefs and polar sea exploration. The book includes maps, charts, deep sea images and black line maps that will allow your students to plot their own findings and notes of discovery. Order from the Web site provided (\$6, plus shipping).

**Recommended for middle–high school geography education.**

**Challenger’s e-Mission: Operation Montserrat**

<http://clc.wju.edu/OM>

Produced by the Challenger Learning Center at Wheeling Jesuit University, Operation Montserrat is based on a real, historical event. The volcano on the normally tranquil island of Montserrat has come to life. As flaming pebbles and lava begin their devastation, emergency response teams learn a hurricane is approaching. Using real-time hurricane and seismic data, teams of student specialists assist Mission Control, by videoconference or over the Internet, in saving the residents from certain destruction. The Mission package includes teacher training workshops, lesson plans, assessment materials and online support.

**Recommended for: grades 5–10.**

**Choosing a Career in Atmospheric Sciences**

<http://oea.larc.nasa.gov/PAIS/AtmSciCareer.html>

A NASA Fact Sheet describing careers and training in atmospheric science, with links to additional resources.

**Recommended for: middle–high school educators.**

**Climate Change Presentation Kit, 1999**

<http://www.epa.gov/enviroed/globalclimate.html>

The *Climate Change Presentation Kit* is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation and interactive activities that are designed to interest audiences of all levels. Order this free CD-ROM at the Web site provided.

**Recommended for:** elementary–college educators, informal educators.

**DataSlate**

<http://catalog.core.nasa.gov/core.nsf/item/400.1-53>

DataSlate is a multi-curricular image visualization tool for students. It allows the user to easily and quickly maneuver through huge image data sets; overlay and compare images gathered over time or with different instruments; and observe historical, geographical, geological and environmental change—or to compare images of the same area at different wavelengths. DataSlate includes a CD-ROM (with 12 sample data sets and 12 sample lesson plans), video and teachers' guide. **Recommended for:** middle–high school.

**Discover Earth Classroom Materials**

<http://www.strategies.org/CLASS.html#Discover>

Discover Earth classroom materials were developed during a series of teacher workshops that were sponsored by NASA. Modules include: *Earth as a System*; *Albedo versus Temperature*; *Ozone*; and *Where Does the Rain Go?* Each module includes the following sections: Key Concepts and Terms, Resources, Background for Teachers, and Classroom Investigations. **Recommended for:** grades 5–12.

**Dr. Art's Guide to Planet Earth**

<http://www.planetguide.net>

*Dr. Art's Guide to Planet Earth* explains the Earth system using three concepts: the cycles of matter, the flows of energy and the web of life. The guide then applies these concepts to real-life problems and issues. Developed by WestEd, this Guide is available for purchase on the Web site above. **Recommended for:** middle+.

**Earth Expeditions: Global Warming**

<http://www.planeteartscience.com>

Students are placed on a research vessel where they run computer climate models to predict how climate in regions around the world may change as the concentration of carbon dioxide in the atmosphere continues to rise. They are charged with determining how climate in four regions of the world (Alaska, northern Canada and Greenland, Europe

and western Russia, western tropical Pacific, and sub-Saharan Africa) may change over the next 100 years as human population continues to increase and non-industrialized nations become industrialized. Their conclusions will help officials advise nations around the world of the potential risks of increased carbon emissions. Students follow the scientific method by testing a given hypothesis on future climate patterns. Computer climate models, a data center and instructional movies are located within the research center to assist them. **Recommended for:** middle–high school.

**Earth Update**

<http://earth.rice.edu/connected/earthupdate.html>

<http://core.nasa.gov>

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. Today's data can be downloaded from the Internet with a single click. Each "sphere" (atmosphere, biosphere, cryosphere, geosphere and hydrosphere) can be run separately or as the linked *Earth Update*. Each sphere includes the sections: What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?) and How (How do we study the geosphere?). The CD includes classroom activities aligned with national science, math and geography standards.

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Space Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth's orbit. This resource can enhance students' studies of Earth and space science, geography, social studies, mathematics and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle.

**Recommended for:** grades 3–12.

**Exploring the Environment**

<http://www.cotf.edu/ete>

This Web site includes online, problem-based modules developed by NASA's Classroom of the Future for K–4, 5–8 and 9–12 teachers and students. The modules address events and issues such as volcanoes, hurricanes, dinosaur extinction theories, deforestation, endangered species and global change. **Recommended for:** grades 5–12.



### Exploring Wetlands with Satellite Sensing Exploring Remote Sensing: A Hands-on Experience

<http://baby.indstate.edu/gerstt/bandsn.html>

In *Exploring Wetlands*, principles of remote sensing and examples of environmental applications using remote sensing present the background required for the hands-on CD. *Exploring Remote Sensing* provides digital remote-sensing data of several small study areas from various environments such as wetlands and volcanoes.

**Recommended for:** grades 7–12.

### Finding Impact Craters with Landsat

<http://landsat.gsfc.nasa.gov/education/crater>

Earth and all the other planets and moons of our Solar System have been continuously pelted by asteroids and comets ever since their formation. On Earth, wind and water have eroded away most of the evidence; various other geologic processes have concealed it; oceans and vegetation now cover much of the rest. This activity will help your students understand how NASA scientists are discovering evidence of impact craters through satellite images and technology, which enables us to see landforms that we can't see with our eyes alone. **Recommended for:** grades 5–8.

### From a Distance: An Introduction to Remote Sensing/GIS/GPS

<http://education.ssc.nasa.gov/ltp>

This Web site includes lesson plans on remote sensing for grades K–3, 4–8 and 9–12, and links to related education resources. **Recommended for:** K–12.

### GLOBE Program Learning Resources

<http://www.globe.gov>

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- **GLOBE Protocol Videos: Atmosphere, Hydrology, Land and Soil**—These videos were created for teachers trained in GLOBE protocols at a GLOBE Workshop to use as a review, in addition to the *Teachers Guide*, before teaching the protocols.
- **GLOBE Videos: Overview, Water Transparency, and Earth as a System**—CD-ROM with sample videos about the GLOBE Program.
- **GLOBE Teachers' Guide**—This guide includes separate chapters on measurement areas (for example, Soils or Earth as a System), data sheets, and lab and field guides for the different measurements.

### How Can We Grow Smarter?

<http://growsmart.gsfc.nasa.gov>

Students use using remote-sensing techniques and data (Landsat, aerial photos and MultiSpec image processing software) to investigate urban sprawl and its consequences in the Washington, D.C. region. The unit design can be customized to suit other problems, besides urban growth, using the same techniques. The lessons can be implemented in a science classroom or in an interdisciplinary manner. **Recommended for:** middle–high school.

### Investigating the Climate System: NASA's Tropical Rainfall Measuring Mission (TRMM)

<http://www.strategies.org/TRMM.html>

This series of five problem-based learning modules is designed to bring NASA TRMM science into the middle school classroom. Modules for grades 5–8 include *Clouds, Precipitation, Weather and Winds*; the fifth module, *Energy*, was developed for high school-level audiences. The modules use role-playing scenarios to help students discover real-world applications of data. While these modules were developed under one series title, they were designed so that each module could be used independently.

**Recommended for grades 5–8 and 9–12.**

### Landsat-7 Datasets: LAN Files for Use with MultiSpec

<http://landsat.gsfc.nasa.gov/education/l7/downloads/index.html>

This site provides a number of Landsat 7 scene subsets as LAN files that are intended for use with Purdue University's MultiSpec software. Users also have the option of downloading the Landsat images as TIFF files in four different band combinations. Links are included to download MultiSpec, a MultiSpec tutorial, and an introduction to remote-sensing PowerPoint presentation with detailed notes.

**Recommended for:** middle school–undergraduate.



**Metropolitan East Coast (MEC) Assessment Educator's Pack**

[http://metroeast\\_climate.ciesin.columbia.edu/edumod.html](http://metroeast_climate.ciesin.columbia.edu/edumod.html)

The MEC Educator's Pack contains geographic information system (GIS) software, data sets and lesson plans designed for educators who are interested in using GIS technology to explore global climate change issues. The package is available on a free, PC-compatible CD (request from the Web site provided), includes a free GIS software program called ArcExplorer by ESRI and comes with a user manual to help get you started. Also provided are two lesson plans that use ArcExplorer to view the data and produce a series of maps to study climate change predictions in the MEC region. **Recommended for: middle–high school.**

**Mission Geography**

<http://missiongeography.org>

<http://catalog.core.nasa.gov/core.nsf/item/400.1-37>

Mission Geography curriculum support materials link the content, skills and perspectives of *Geography for Life: The National Geography Standards* with NASA missions, research and science. Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. **Recommended for: K–12.**

**NASAexplores**

<http://nasaexplores.com>

NASAexplores provides free weekly K–12 educational articles and lessons on current NASA projects. While many articles focus on aerospace technology and human exploration and development of space, several Earth science articles and lessons appear, such as *Mapping the Earth from Space*, *I am a Sensor*, *Volcanoes from the Sky*, *Relief Maps*, *Making a Topographic Map*, *Thickness of the Atmosphere* and many others. **Recommended for: K–12.**

**Numbers to Pictures**

<http://imagers.gsfc.nasa.gov/teachersite/RGB>

When satellites observe colors from the Earth's surface, the amounts of reflected light are recorded as numbers. This activity illustrates how satellite images are made using flashlights and a color-by-number activity. Students mix the primary colors of light using flashlights (or a Web-based version), investigate the interactions of the light and experiment with trying to create as many colors possible. The activity leads to quantifying the amount of light used to make each color, which students use to "process" a remote-sensed image presented as a color-by-number activity. **Recommended for: middle school.**

**OceanWorld**

<http://oceanworld.tamu.edu>

Ocean World was developed by Texas A&M University and contains information about many important processes in the ocean. The information about processes is linked to teaching material on other sites and to sources of real-time data that can be used in the classroom. The site also has complete college-level and graduate courses in oceanography and physical oceanography. K–12 material is tied to national and Texas standards for teaching science and mathematics. **Recommended for: middle–high school and undergraduate.**

**Pacific Expeditions: El Niño**

<http://www.planearthsci.com>

This CD-ROM engages students in a journey where they must navigate their own ship, operate modern research tools, and manipulate satellite and climate model data to investigate and help predict El Niño—one of our planet's largest global climactic disruptions.

**Recommended for: middle–high school.**

**The Potential Consequences of Climate Variability and Change**

<http://www.strategies.org/CLASS.html#Climate>

The potential impacts of climate variability and change provide the context for these inquiry-based activities. The modules include climate change overview activities for grades 1–4 and 5–12, as well as modules that examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health and water.

**Recommended for: grades 1–12.**

**River Expeditions: The Amazon**

<http://www.planearthsci.com>

This CD-ROM brings Earth system science concepts to life by challenging students to conduct modern ecosystem research as it really happens. Students are engaged in a research expedition on the Amazon River flood plain, where they apply modern chemical techniques and evaluate satellite data to discover the role of the floodplain in the trophic ecology of Amazon River fishes.

**Recommended for: middle–high school.**

**Science Seekers: Hidden in Rocks**

<http://www.tomsnyder.com>

The American Museum of Natural History developed *Science Seekers*—middle school learning resources that includes CD-ROMs, teacher's guides and hands-on kits. In *Hidden in Rocks*, students play a team of science problem-solvers on special assignment to learn about rock types and

rock formations as they explore how scientists use satellite visualizations to help them identify rocks that might contain fossils. *Hidden in Rocks* consists of three investigations—How does uplift change Earth's surface?; Which rocks contain fossils?; and How does erosion change the landscape?—during which students research information to help them achieve their mission objective. During each investigation, students work in cooperative teams to answer questions that will move them closer to solving the problem. Each step of the way, professional scientists guide students' investigations, describing how they've used technological tools, such as satellite imagery, to solve similar problems—so that students have opportunities to use some of the same technological tools in their mission.

**Recommended for: middle school.**

### Science Seekers: Safe Water

<http://www.tomsnyder.com>

The American Museum of Natural History developed *Science Seekers*—middle school learning resources that includes CD-ROMs, teacher's guides and hands-on kits. In *Safe Water*, students play a team of science problem-solvers on special assignment to investigate how water flows under ground as they use a model to rule out sources of water pollution in a small town. *Safe Water* consists of three investigations—What is groundwater?; How does groundwater get underground?; and Where does groundwater go?—during which students research information to help them achieve their mission objective. During each investigation, students work in cooperative teams to answer questions that will move them closer to solving the problem. Each step of the way, professional scientists guide students' investigations, describing how they've used technological tools, such as computer modeling, to solve similar problems—so that students have opportunities to use some of the same technological tools in their mission. **Recommended for: middle school.**

### Students' Cloud Observations Online (S'COOL)

<http://scool.larc.nasa.gov>

S'COOL is a real-time, collaborative science experiment that elementary through secondary students conduct with NASA scientists. Participants make ground truth observations of clouds for comparison with satellite data. These observations help NASA scientists validate the measurements from NASA's CERES satellite instrument (Clouds and Earth's Radiant Energy System). The following S'COOL educational resources are available to support the program:

- **Cloud Identification Chart** ([http://asd-www.larc.nasa.gov/SCOOL/Cloud\\_ID.html](http://asd-www.larc.nasa.gov/SCOOL/Cloud_ID.html))—Shows examples of different cloud types and classification, identifies cloud observation basics and information on how clouds were named, and provides an activity on how to make

a cloud in a bottle. **Recommended for grades 3–8.**

- **S'COOL Tutorial** (<http://asd-www.larc.nasa.gov/SCOOL/tutorial/scool.html>)—Covers the following: determining satellite overpass time, observing cloud properties, transmitting results to NASA, and comparing results with satellite-retrieved properties. **Recommended for grades 3–8.**
- **Student and Teacher Bookmarks** (<http://asd-www.larc.nasa.gov/SCOOL/bookmarks.html>)—Provide basic information about the importance of ground truth measurements for investigative science and the formation of clouds. **Recommended for grades 3–8.**
- **S'COOL Poster and Brochure** ([http://asd-www.larc.nasa.gov/SCOOL/post\\_broch.html](http://asd-www.larc.nasa.gov/SCOOL/post_broch.html))—Provide photos of different cloud types, and information describing the program and how to participate. **Recommended for: grades 3–12.**
- **S'COOL Web Site** (<http://scool.larc.nasa.gov>)—Provides information on the project and how to participate, as well as classroom materials and resources. **Recommended for: grades 3–12.**

### Understanding the Biosphere from the Top Down

[http://geo.arc.nasa.gov/sge/jskiles/top-down/intro\\_product/title-page.html](http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html)

Published in 1996, the 22 lessons in this package focus on studying the biosphere from space to teach students about the Earth system. **Recommended for: grades 4–12.**

### Virtual Vacationland

<http://www.bigelow.org/virtual>

The site includes over 40 hands-on activities on the following science topics: land topography, ocean bathymetry, coastal tides, ocean buoy data, ocean temperature, weather and climate, and watersheds and rivers. Each topic has a preview page that summarizes the material. Each topic also has 2 to 5 detail pages, which show where to access online data related to the topic and what the data mean.

**Recommended for: elementary–secondary.**

### Windows to the Universe

<http://www.windows.ucar.edu>

*Windows to the Universe* brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities. Three levels of content are provided: students (K–12 through undergraduate), teachers and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games and data that brings science to life for students, teachers and the interested user.

**Recommended for: K–12, informal education.**

**World Watcher: Global Warming Project**

<http://www.worldwatcher.northwestern.edu/curriculum/MS.btm>

Global warming and its potential impact provide the context for this unit, in which students learn about the scientific factors contributing to the debate. Students act as advisors to the heads of state of several nations and explore the issues as they respond to the various questions and concerns of these leaders. Activities include a combination of physical labs and investigations using World Watcher software, a geographic data visualization tool. Developed by Northwestern University.

**Recommended for: middle school+.**

**HIGH SCHOOL****Arctic Observatory/Sea Ice in the Polar Regions**

<http://catalog.core.nasa.gov/core.nsf/item/400.0-90>

The *Arctic Observatory* includes a teacher's guide and interactively deals with Arctic phenomena and processes, allowing students to ask and answer questions about interrelationships between several physical aspects of the Arctic system. *Sea Ice in the Polar Regions* is a presentation that describes sea ice classification, observation and climate impacts, with voice-over narration. Both resources are available on one CD-ROM from NASA CORE; they can also be downloaded at: <http://www.usra.edu/esse/learnmod.btml>.

**Recommended for: high school–adult.**

**Asian Monsoon**

<http://catalog.core.nasa.gov/core.nsf/item/400.1-47>

Students are guided through an investigative journey of the Asian monsoon season, studying weather and climate patterns and their effects on local and world environments. The CD-ROM contains complete teacher, student and resource guides (PDF files) and a Data Visualizer with 4,000 data graphs. A presentation of how the Asian monsoon is studied through data assimilation contains seven QuickTime movies of data and scenes from Asia.

**Recommended for: high school.**

**CEOS Resources in Earth Observation**

<http://ceos.cnes.fr:8100/cdrom-98/astart.btm>

The international Committee on Earth Observation Satellites (CEOS) has produced this resource, which contains case studies (examples of Earth observation applications to real-life problems), data and information for education and developing countries. **Recommended for: high school, undergraduate, graduate–professional.**

**ChemMatters Special Editions on NASA's EOS Aura**

<http://chemistry.org>

Click on the link to “Educators and Students,” scroll down to “High School” and click on the link to “ChemMatters.”

*ChemMatters* is a quarterly publication of the American Chemical Society, designed and written to demystify everyday chemistry for high school students. The magazine is devoting four special issues annually (beginning in 2001) that will focus on atmospheric chemistry and NASA's Aura mission. Aura will study Earth's ozone, air quality and climate, and conduct research on the composition, chemistry and dynamics of Earth's atmosphere. In addition to science topics, the articles also feature the people behind the mission; each issue also includes a teachers' guide. The special NASA issues and teachers' guides can be freely downloaded as PDF files. **Recommended for: high school.**

**Geomorphology from Space, 1986**

[http://daac.gsfc.nasa.gov/DAAC\\_DOCS/geomorphology/GEO\\_HOME\\_PAGE.btml](http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_HOME_PAGE.btml)

<http://catalog.core.nasa.gov/core.nsf/item/400.0-87>

Available on CD and the Web, *Geomorphology from Space* was designed for studying landforms and landscapes. It contains a gallery of 237 color and black and white plates of space imagery, primarily of the Earth, each treating a geographic region where a particular landform theme is exemplified. Each image is paired with a detailed scientific description of the features in the image; some images are accompanied by line drawings, locator maps, geologic maps and on-the-ground photographs of the landform. Available on CD-ROM from NASA CORE at the Web site provided.

**Recommended for: high school–adult.**

**Global Systems Science (GSS)**

<http://www.lbs.berkeley.edu/GSS>

The GSS Student Books, developed at the Lawrence Hall of Science, can be combined in various ways to create an interdisciplinary high school course. In the GSS approach, students integrate the traditional disciplines to probe the interactions among the atmosphere, ocean, ice, solid Earth and living organisms that shape Earth's evolution and its future. Students study the traditional disciplines, not as ends in themselves, but as tools for a scientific understanding of Earth as an integrated system. The following GSS books are on topics related to NASA's Earth Science Enterprise: *GSS Teachers' Guide*, *New World View*, *Climate Change*, *Losing Biodiversity* and *Energy Flow*.

**Recommended for: grades 9–12.**



## Into the Arctic: Information and Education Activities for Studying Climate

<http://arcss.colorado.edu/data/arcss069.html>

The University of Colorado/CIRES developed this CD-ROM on climate and climate history in the Arctic, which uses real data and questions from the Greenland Ice Sheet Project Two (GISP2). The lessons and activities are designed for studying Earth science, geography, history, social studies or chemistry. Information and activities are divided into four sections: Climate, Climate Change, El Niño and the GISP 2. **Recommended for: grades 9–12, lower-level undergraduate.**

## Journeys through Earth and Space

Guide—<http://ct.gsfc.nasa.gov/journeys>

Video—<http://catalog.core.nasa.gov/core.nsf/item/002.2-33V>

Why are the Rocky Mountains so far inland? How do we preserve the changing Amazon rainforest? When will the Sun fling parts of itself towards Earth? The video magazine *Journeys through Earth and Space* follows three NASA research teams tackling these questions with supercomputers. Researcher interviews mix with scientific imagery and stunning nature footage. An accompanying *Video Resource Guide* provides background material and classroom activities for grades 9–12. Download the Guide from <http://ct.gsfc.nasa.gov/journeys>—or order from NASA CORE, \$3. Order videotape from NASA CORE at the Web site provided, item # 002.2-33V, \$15. Length: 18:00.

**Recommended for: grades 9–12.**

## Studying Earth's Environment from Space

<http://www.ccpo.odu.edu/SEES/index.html>

<http://catalog.core.nasa.gov/core.nsf/item/400.1-46>

This material consists of four modules designed to increase the use of satellite data in science classrooms: *Stratospheric Ozone*, *Global Land Vegetation*, *Oceanography* and *Polar Sea Ice Processes*. Lecture materials are provided, including full-color, printable graphics that are linked to guided-inquiry computer exercises. The software package used for the computer exercises is SEE Image, which is a modified version of NIH-Image. The software runs on Macintosh computers, as well as PCs that are equipped with a Macintosh emulator.

**Recommended for: high school–undergraduate.**

## Understanding the Biosphere from the Top Down

[http://geo.arc.nasa.gov/sge/jskiles/top-down/intro\\_product/title-page.html](http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html)

Published in 1996, the 22 lessons in this package focus on studying the biosphere from space to teach students about the Earth system. **Recommended for: grades 4–12.**

## Resources

*The following resources can be useful for developing lesson plans, curriculum supplements, student research projects and sources of NASA Earth science research information and imagery.*

### BOOKMARKS

#### Climate Change Bookmarks

This set of bookmarks developed by NASA Langley Research Center includes: *Ozone*, *Biomass Burning*, *Volcanic Aerosols*, *Clouds* and *Human and Natural Impacts on the Earth*. Each bookmark provides a Web address for additional information. Available online at: <http://asd-www.larc.nasa.gov>.

**Recommended for: middle school+.**

### BOOK COVERS

#### Mathematics of the Great Dismal Swamp—Book Cover

<http://nia.ecsu.edu/nrts/ess/mds/images/bookcover01.jpg>

This book cover was developed by Elizabeth City State University as part of its Mathematic of the Great Dismal Swamp education project.

**Recommended for grades 3–8.**

### BOOKS

#### Atlas of the Ocean: The Deep Frontier, 2001

<http://sbop.nationalgeographic.com>

Featuring more than 150 photographs, maps and NASA satellite images, this atlas charts and celebrates every aspect of the ocean world, from tiny plankton to massive storm systems that rage across thousands of miles. Experts have contributed essays and sidebars on subjects as diverse as deep-sea archeology, plate tectonics, coral reefs, mapping techniques and El Niño. Readers also go behind the scenes to observe modern science at work, as researchers pursue promising leads in dozens of different but intertwined fields. Order online at the URL provided—or from: National Geographic Society, 1145 17th Street NW, Washington, DC 20036-4688. *Atlas of the Ocean: The Deep Frontier Teacher's Guide* is a 30-page classroom activity guide that features content taken from the atlas. Subjects include undersea hot spots, underwater archae-



ology, bioluminescence, coral reefs and polar sea exploration. Order the teachers' guide from NASA CORE at <http://catalog.core.nasa.gov/core.nsf/item/300.1-28P> (\$6, plus shipping).

**The atlas is recommended for: formal and informal education audiences, grade 8–adult; the teachers' guide is recommended for middle–high school geography education.**

## ■ BROCHURES

### NASA's Earth Observing System: Terra Spacecraft

[http://eospsso.gsfc.nasa.gov/ftp\\_docs/Terra\\_brochure.pdf](http://eospsso.gsfc.nasa.gov/ftp_docs/Terra_brochure.pdf)

This brochure gives a brief overview of the Earth science research that is being done with data from the instruments onboard NASA's Terra spacecraft.

## ■ EARTH SCIENCE DATA & IMAGERY

See also the section on Web sites (p. 18) for a list of individual Earth science missions.

### Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

**Recommended for: general public, media, informal educators and middle school–post secondary instruction.**

### Earth Science Picture of the Day (EPOD)

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic.

**Recommended for: middle school+, informal education.**

### Gateway to Astronaut Photography of Earth

<http://eol.jsc.nasa.gov>

This Web site hosts the best and most complete online collection of astronaut photographs of the Earth, including over 480,000 photos from Space Shuttle and the International Space Station. Users can search the database of photos by geographic coordinates or region, mission, features, cloud cover and many other options. The site also features an image of the week, as well as special collections of images, including: Cities, Earth Landscape, Earth-Human Interaction, Distinctive Features, Hurricanes and Weather, Earth's Water Habitat and Geographical Regions.

### NASA Distributed Active Archive Centers (DAACs)

<http://nasadaacs.eos.nasa.gov>

The NASA DAACs are the data management and user services branches of NASA's Earth Observing System Data and Information System (EOSDIS). The DAACs process, archive, document and distribute data from NASA's past and current Earth science research satellites and field measurement programs. They were established in the early 1990s, and each DAAC serves a specific science discipline. The DAAC Alliance Annual Feature Articles (<http://nasadaacs.eos.nasa.gov/year-books/index.html>) illustrate how these data sets are being used for wide-ranging science research and applications purposes.

**Recommended for: high school educators, undergraduate, graduate–professional.**

### Landsat-7 Datasets: LAN Files for Use with MultiSpec

<http://landsat.gsfc.nasa.gov/education/l7/downloads/index.html>

This site provides a number of Landsat 7 scene subsets as LAN files that are intended for use with Purdue University's MultiSpec software. Users also have the option of downloading the Landsat images as TIFF files in four different band combinations. Links are included to download MultiSpec, a MultiSpec tutorial, and an introduction to remote-sensing PowerPoint presentation with detailed notes. **Recommended for: middle school–undergraduate.**

### United States of America Digital Landsat Mosaics: a 4-CD set of Landsat satellite imagery of the fifty states

<http://catalog.core.nasa.gov/core.nsf/item/400.1-52>

Using the US Digital Landsat Mosaics, we can increase our understanding of Earth system science and the effects humans have on the global environment. The mosaics were developed primarily from data collected by the Landsat 4 and Landsat 5 satellites as they orbited the Earth ten or more years ago. This historical imagery is a

valuable record of the conditions on Earth around the year 1990. The CD was developed by NASA Stennis Space Center and the US Geological Survey. It also includes a basic Landsat tutorial.

**Recommended for:** high school–adult.

### Visible Earth

<http://visibleearth.nasa.gov>

This companion site to the NASA *Earth Observatory* (<http://earthobservatory.nasa.gov>) is a comprehensive image gallery for access to NASA Earth science images, animations and data visualizations. Most resources are available digitally at multiple resolutions, with captions and metadata. **Recommended for:** media and general public.

## ■ LITHOGRAPHS

Lithographs contain a color image (e.g., a satellite image), with additional information, classroom activities or discussion questions.

The following lithographs are available to download from NASA Spacelink at: <http://spacelink.nasa.gov/products>.

- 1997-998 El Niño (LG-1998-05-004-GSFC)
- Apollo 17 View of Earth (HqL-363)
- Exploring Earth from Space (LS-2002-12-HQ)
- First Image of the Global Biosphere (HqL-325)
- Understanding Our Changing Planet (HqL-430)
- Water is a Force of Change (HqL-401)
- World Cloud Cover Pattern (HqL-326)

### Digital Tectonic Activity Map: Lithograph with Activities

<http://denali.gsfc.nasa.gov/dtam>

The Digital Tectonic Activity Map (DTEM) is a digital atlas of tectonism and volcanism of the last one million years. It is a compilation of field, geophysical and satellite measurements. The lithograph introduces the DTAM to the classroom, utilizing the map with online activities.

**Recommended for:** high school+.

### Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-2002-12-HQ

<http://spacelink.nasa.gov/products/Exploring.Earth>.

*From Space*

<http://catalog.core.nasa.gov/core.nsf/item/300.1-36P>

Space Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth's orbit. This resource can enhance students' studies of Earth and space science, geography, social

studies, mathematics and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle. **Recommended for:** grades 3–12.

### GOES Hurricane Linda

<http://www.gsfc.nasa.gov/gsfc/service/gallery/lithos/goes-linda.pdf>

This NASA lithograph presents a GOES satellite image of Hurricane Linda as it approached Baja, California on September 12, 1997. A brief explanation of how hurricanes are formed and a classroom exercise is on the back. **Recommended for:** middle–high school.

### Landsat 7—New York City: Amelia's Adventures in New York City

<http://imagers.gsfc.nasa.gov/amelia/teachersguide/NYClitho>

This lithograph shows a Landsat 7 image of New York City and includes an activity for children ages 5–9. The imagery highlights vegetation, emphasizing location, shape and sizes of parks. The activity engages children in following Amelia the Pigeon's adventure around the parks in New York City. The lithograph is a companion piece to the *Amelia the Pigeon Interactive Adventure*—at <http://imagers.gsfc.nasa.gov/amelia>.

**Recommended for:** ages 5–10.

## ■ NASA FACTS

NASA Facts are educational brochures that provide general information and background on NASA-related missions, research topics and activities.

### Choosing a Career in Atmospheric Sciences

<http://oea.larc.nasa.gov/PAIS/AtmSciCareer.html>

The following Earth science NASA Facts are available online at: [http://eospsa.gsfc.nasa.gov/eos\\_homepage/for\\_educators/facts.php](http://eospsa.gsfc.nasa.gov/eos_homepage/for_educators/facts.php)

- Clouds and the Energy Cycle—NF-207, August 1999
- El Niño—NF-211, August 1999
- Global Warming—NF-222, April 1998
- Polar Ice—NF-212, April 1998
- Tropical Deforestation—FS-1998-11-120-GSFC, November 1998

## ■ POSTERS

### **EOS Science Poster Series: Air, Land, Water and Ice**

[http://eospsso.gsfc.nasa.gov/eos\\_homepage/for\\_educators/eos\\_posters/index.php](http://eospsso.gsfc.nasa.gov/eos_homepage/for_educators/eos_posters/index.php)

Explore recent images and research results from NASA Earth science missions with these informative, eye-catching posters. Each poster takes a specific topic (air, land, water or ice) and explains what NASA scientists are doing to understand that topic. Colorful and instructional satellite images, graphs and pictures complement the fact-filled information making the posters ideal for the classroom. The posters can be ordered from the Web site provided; this site also includes PowerPoint and PDF files with the poster information. **Recommended for: middle school–post secondary.**

### **From the Top of the World to the Bottom of the Food Web**

<http://www.bigelow.org/foodweb>  
<http://catalog.core.nasa.gov/core.nsf/item/300.1-25P>

This educational wall sheet and associated Web site were developed by Bigelow Laboratory for Ocean Sciences to help teachers and students discover linkages among marine ecology, phytoplankton, the behavior of light at the ocean surface and satellite-derived ocean color data. The poster can be ordered from the Web sites listed above. **Recommended for: middle school+.**

### **Night Lights Poster**

<http://catalog.core.nasa.gov/core.nsf/item/300.1-18P>

Much of Earth is illuminated at night by city lights. This NASA-produced poster shows a global view of Earth at night, compiled from over 400 satellite images collected during the nighttime phase of the orbit. Includes activities on the poster backside for elementary–secondary classes from Mission Geography (<http://missiongeography.org>). The poster can be ordered from the Web site provided. **Recommended for: K–12.**

### **SeaWiFS Poster with Teaching Supplement**

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

This poster includes remote-sensing images from NASA's Sea-viewing Wide Field-of-View Sensor (SeaWiFS). The teaching supplement augments the poster with descriptive summaries of the variety of geophysical phenomena that can be seen in each image. The supplement also includes a glossary of terms and a listing of URLs for additional information. **Recommended for: upper high school–undergraduate.**

## ■ SLIDE SETS 35mm

### **Earthview**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-29>

This set of 4 slides presents photographs of Earth taken from four different Apollo missions (1969–1985). Provided by NASA's Public Affairs Office. Order from the Web site provided, item # 100.0-29, \$3.00.

### **Fragile Earth**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-26>

This slide set with script provides space photographs and satellite images that illustrate how both nature and people have changed Earth. Order from the Web site provided, item # 100.0-26, \$8.50.

### **Full Earth**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-30>

This slide set (6 slides) presents photographs of Earth taken from various Apollo missions and NASA's Applications Technology Satellite (ATS-3), 1968–1985. Provided by NASA's Public Affairs Office. Order from the Web site provided, item # 100.0-30, \$3.50.

### **The Ultimate Field Trip: An Astronaut's View of Earth**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-57>

This slide set and booklet includes a collection of 24 views of the Earth witnessed by NASA Astronaut Dr. Kathryn Sullivan while aboard the Space Shuttle. This material was adapted from a version published in *Update*, the newsletter of the National Geographic Society's Geography Education Program, Fall 1991. Order from NASA CORE at the Web site provided, item # 100.0-57, \$8.50. **Recommended for: middle–junior high school.**

### **United States Geography: United States Cities**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-54>

Sixty slides with descriptions of different US cities, offering photographs taken by astronauts aboard the Space Shuttle. Features cities, roads, airports and dams, as well as natural settings, including oceans, rivers, mountains and plains. The list accompanying each set contains the photo number by which additional prints can be ordered. Order from the Web site provided, item # 100.0-54, \$26.

The following regional slide sets are also available:

- **United States Geography: Appalachians, Ohio River Valley, Great Lakes**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-50>  
 20 slides with descriptions; item # 100.0-50, \$10.

- **United States Geography: East Coast States, New England to Florida**  
<http://catalog.core.nasa.gov/core.nsf/item/100.0-49>  
20 slides with descriptions; item # 100.0-49, \$10.
- **United States Geography: Great Plains and Mississippi River Valley**  
<http://catalog.core.nasa.gov/core.nsf/item/100.0-51>  
20 slides with descriptions; item # 100.0-51, \$10.
- **United States Geography: Rocky Mountains and Southwest**  
<http://catalog.core.nasa.gov/core.nsf/item/100.0-52>  
20 slides with descriptions; item # 100.0-52, \$10.
- **United States Geography: West Coast States, Alaska, and Hawaii**  
<http://catalog.core.nasa.gov/core.nsf/item/100.0-53>  
20 slides with descriptions; item # 100.0-53, \$10.

## ■ VIDEOTAPES

The following are videotapes related to NASA's ESE and are available for purchase from NASA CORE at the Web sites listed.

### **Blue Planet, 1990**

Video—<http://catalog.core.nasa.gov/core.nsf/item/002.2-15V>

DVD—<http://catalog.core.nasa.gov/core.nsf/item/002.2-15D>

Filmed by astronauts from five Space Shuttle missions with an IMAX camera, this video dramatically reveals the forces affecting Earth's ecological balance: volcanoes, hurricanes, earthquakes and, ultimately, humankind. Experiments discussed in this videotape focus on infrared detection of atmospheric remnants from volcanic eruptions, ozone concentration levels and incoming solar ultraviolet radiation with respect to global warming. Order from NASA CORE at the Web sites provided; available in 1/2" VHS (Item # 002.2-15V, \$14.95) and DVD (Item # 002.2-15D, \$20). Length: 42:00.

**Recommended for: grade 4–adult.**

### **Catch the Wind: the QuikSCAT Video, 2001**

<http://catalog.core.nasa.gov/core.nsf/item/002.2-27V>

*Catch the Wind* tells the story from inception to launch of NASA's quick scatterometer project (QuikSCAT), which gives a behind-the-scenes look at engineers, scientists and technicians working together to solve problems and successfully accomplish goals. Order from NASA CORE at the Web site provided, item # 002.2-27V, \$16. Length: 25:22.

**Recommended for: middle school–adult.**

### **Glacier Bay, Alaska, From the Ground, Air and Space, 1996**

<http://catalog.core.nasa.gov/core.nsf/item/002.2-16V>

Bring glaciers to life with nine spectacular “fly-bys” of scenic rides over 3-dimensional glaciers, live video footage of ice fronts calving into the sea, and dramatic picture sequences of historical and satellite data. This video shows how a NASA glaciologist has learned about glaciers and how their formation could be related to climate change. Order from NASA CORE at the Web site provided, item # 002.2-16V, \$15. In addition to NASA CORE, this video is also available online at:

<http://sdcd.gsfc.nasa.gov/GLACIER.BAY/glacierbay.story.html>. Length: 13:15. **Recommended for: grade 5–adult.**

### **Jason: An Ocean Odyssey Video, 2001**

<http://catalog.core.nasa.gov/core.nsf/item/002.2-23>

Jason is joint U.S.-France oceanography mission to monitor global ocean circulation, discover the tie between the oceans and atmosphere, improve global climate predictions and monitor events such as El Niño conditions and ocean eddies. Jason-1 is a follow-on mission to the highly successful TOPEX/Poseidon mission. Order from NASA CORE at the Web site provided, item # 002.2-23, \$10. Length: 9:00. **Recommended for: grade 5–adult.**

### **Journeys through Earth and Space**

Guide—<http://ct.gsfc.nasa.gov/journeys>

Video—<http://catalog.core.nasa.gov/core.nsf/item/002.2-33V>

Why are the Rocky Mountains so far inland? How do we preserve the changing Amazon rainforest? When will the Sun fling parts of itself towards Earth? The video magazine *Journeys through Earth and Space* follows three NASA research teams tackling these questions with supercomputers. Researcher interviews mix with scientific imagery and stunning nature footage. An accompanying *Video Resource Guide* provides background material and classroom activities for Grades 9–12. The Guide can be downloaded from <http://ct.gsfc.nasa.gov/journeys> or ordered for \$3 from NASA CORE. Order videotape from NASA CORE at the Web site provided, item number 002.2-33V, \$15. Length: 18:00.

**Recommended for: grades 9–12.**

### **Liftoff to Learning: Geography From Space, 1997**

<http://catalog.core.nasa.gov/core.nsf/item/008.0-09V>

This video takes the viewer on a rapid tour of Earth's surface as seen from the Space Shuttle. After explaining how the altitude of the viewer affects the amount of Earth's surfaces seen at one time, the video moves into a



travelogue on some of the interesting features of Earth's continents as seen from space. Order from NASA CORE at the Web site provided, item # 008.0-09V, \$15. Length: 15:00. **Recommended for: elementary–middle school.**

### NASA CONNECT™

#### Data Analysis and Measurement: Ahead, Above the Clouds

<http://connect.larc.nasa.gov>

NASA CONNECT™ is a series of free, 30-minute, standards-based instructional distance learning programs for students in grades 5–8. In *Data Analysis and Measurement: Ahead, Above the Clouds*, students learn about hurricanes and how meteorologists, weather officers, and NASA researchers use measurement and data analysis to predict severe weather. Episodes are available from the NASA CONNECT™ Web site ([http://connect.larc.nasa.gov/programs/2000-2001/ahead\\_clouds.html](http://connect.larc.nasa.gov/programs/2000-2001/ahead_clouds.html)), or can be ordered on videotape from NASA CORE at <http://core.nasa.gov>.

#### NASA on the Cutting Edge: Our Water Planet from Space, 1998

<http://catalog.core.nasa.gov/core.nsf/item/002.2-21V>

Our *Water Planet from Space* is a videotape of two previously broadcast (1998) live interactive shows that explore the world's oceans. Order from NASA CORE at the Web site provided, item # 002.2-21V, \$16.00. Length: 60:00 (two 30:00 shows).

- *Program 1: Oceans in Motion*—Ocean circulation: how it works and the important role it plays in our lives.
- *Program 2: The Color of Oceans*—Ocean productivity, ecosystems and human impacts.

**Recommended for: middle–high school.**

### NASA SCI Files™

<http://scifiles.larc.nasa.gov>

The NASA SCI Files™ distance learning series introduces students in grades 3–5 to NASA and integrates mathematics, science and technology through the use of Problem-Based Learning (PBL), scientific inquiry, and the scientific method. The programs can be viewed and videotaped at no cost on PBS-member TV stations and via satellite broadcast.

Episodes can also be viewed for free on the Internet via NASA's Learning Technologies channel: <http://quest.arc.nasa.gov/events/sci/index.html> and Knowitall.org at: [http://www.knowitall.org/nasa/btml\\_wm/scifiles.html](http://www.knowitall.org/nasa/btml_wm/scifiles.html). You can also contact your local NASA Educator Resource Center (<http://education.nasa.gov/erc>) for a video copy or purchase an episode on videotape from NASA CORE at

<http://core.nasa.gov>. The following are Earth science shows that appeared on the NASA SCI Files™:

- ***The Case of the Mysterious Red Light and The Case of the Phenomenal Weather***

<http://quest.arc.nasa.gov/events/sci/2001/index.html>

- ***The Case of the Shakey Quake***

<http://quest.arc.nasa.gov/events/sci/2002/index.html>

#### Our Home: Earth from Space, 2002

<http://catalog.core.nasa.gov/core.nsf/item/002.2-31V>

Two student moderators engage the audience with satellite imagery, computer graphics and historical footage to make the point that the Earth is an interconnected system of air, land, water and life. The video includes the following segments: An Introduction to Earth System Science, Using Satellites to Look at Earth from Space, El Niño, Global Warming, Drought, Hurricanes and an Epilogue. Order from NASA CORE at the Web site provided, item # 002.2-31V, \$15. Length: 22:00. The video can also be downloaded as QuickTime movies from:

<http://edmall.gsfc.nasa.gov/video>.

**Recommended for: high school.**

#### SunSplash, 1997

<http://catalog.core.nasa.gov/core.nsf/item/002.2-18V>

SunSplash explains ozone depletion, using computer graphics and animation. The educational narrative explains how ozone in the stratosphere protects us from ultraviolet radiation and demonstrates how chlorofluorocarbons (CFCs) cause destruction of the Earth's protective ozone layer. Order from NASA CORE at the Web site provided, item # 002.2-18V, \$10. Length: 7:52.

**Recommended for: high school.**

#### UARS—The Upper Atmosphere Research Satellite Video and Resource Guide, 2001

<http://catalog.core.nasa.gov/core.nsf/item/002.2-26V>

This videotape was created to be a resource for helping to understand stratospheric ozone. The instruments aboard UARS and their measurements are described in the tape and how they help in studying humankind's influence on ozone. Order from NASA CORE at the Web site provided, item # 002.2-26V, \$15. Length: 17:00.

**Recommended for: high school–undergraduate.**

#### Underground Railroad: Connections to Freedom and Science, 1999

<http://catalog.core.nasa.gov/core.nsf/item/008.0-10V>

A collaboration between NASA and the National Park Service, this educational video details how the sciences of astronomy and geography guided slaves to freedom in the 1800s, and how the technologies of satellites and

geographic information systems are being used to locate and visualize the secret paths they traveled.

Using the North Star as a compass, freedom-seeking slaves went from safe house to safe house along the Underground Railroad, an intricate network of escape routes away from the slave-ridden South. This video explains the role celestial navigation played in the Railroad's success, and highlights the importance of modern technologies in reconstructing the exact routes and terrain of the Railroad. Order from NASA CORE at the Web site provided, item # 008.0-10V, \$16. Length: 34:00. **Recommended for: middle–high school.**

### **The Weather Watchers, 1977**

<http://catalog.core.nasa.gov/core.nsf/item/002.3-02V>

This 1977 video provides historical footage regarding the importance of meteorological information obtained from NASA satellites for predicting and monitoring severe storms. Order from NASA CORE at the Web site provided, item # 002.3-02V, \$15. Length: 15:00.

**Recommended for: grades 7–11.**

## ■ WEB SITES

### **Destination Earth**

<http://www.earth.nasa.gov>

Destination Earth is the official Web site for NASA's ESE. It includes current ESE news and events, sections on education for teachers and students and information on current research opportunities. Many links to other information resources are also included.

### **Earth Science Picture of the Day (EPOD)**

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic.

**Recommended for: middle school+, informal education.**

### **Earth Observatory**

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics,

download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

**Recommended for: general public, media, informal educators and middle school–post secondary instruction.**

### **EOS Project Science Office**

<http://eospsso.gsfc.nasa.gov>

The Earth Observing System (EOS) is the centerpiece of NASA's ESE. It is composed of a series of satellites, a science component and a data system supporting a coordinated series of satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere and oceans. The EOS Project Science Office is committed to bringing program information and resources to program scientists and the general public alike. Visit the project's Web site to find resources for educators, including educational links and publications from the EOS program. **Recommended for: elementary–secondary educators, undergraduate–graduate.**

### **NASA Earth Science Missions—Education Programs and Resources**

Many of NASA's Earth science missions have an education and/or public outreach component. These efforts include a wide variety of activities and resources for educators, students and the public, including teacher workshops, public programs and events, and curriculum and classroom materials. Visit the Web sites listed with each mission for specific information on a mission's programs and resources, including access to satellite imagery and other data. Missions are listed by year of launch or scheduled launch.

#### **TOPEX/Poseidon**

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, the TOPEX/Poseidon satellite uses radar altimeters to continuously survey ocean surface height. The Jason-1 satellite joined TOPEX/Poseidon in orbit in 2001 to collect similar data.

Scientists are using TOPEX/Poseidon and Jason-1 data to learn more about global ocean circulation patterns, including phenomena such as El Niño/La Niña. Oceans are a key mechanism in transporting heat from the Sun around the globe. Researchers are working to improve understanding of the role oceans play in controlling seasonal variations and longer-term climate changes. Ocean altimetry data are also used for operational purposes, including ship routing, fisheries man-

agement, hurricane forecasting and support of underwater activities like cable laying. **CONTACT:** Annie Richardson or Mona Jasnow, Jet Propulsion Laboratory, **Email:** [topex@jpl.nasa.gov](mailto:topex@jpl.nasa.gov). (Launched: 1992)

#### **SeaWiFS**

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is providing quantitative data on global ocean bio-optical properties. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. SeaWiFS has helped us to not only monitor the short-term spatial and temporal variability in the ocean's biology, but also to have the first well-calibrated, long-term data set that allows us to quantify the ocean's biological response to global change. (Launched: 1997)

#### **Tropical Rainfall Measuring Mission (TRMM)**

<http://trmm.gsfc.nasa.gov>

<http://strategies.org/TRMM.html>

TRMM is a joint mission between NASA and the National Space Development Agency of Japan (NASDA). It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulations shaping both weather and climate around the world. **CONTACT:** Jeffrey Halverson, TRMM Education and Outreach Scientist, Code 912, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6333, **Email:** [halverson@agnes.gsfc.nasa.gov](mailto:halverson@agnes.gsfc.nasa.gov). (1997 launch)

#### **ACRIMSAT**

<http://acrim.jpl.nasa.gov/education/eduindex.html>

Using the Active Cavity Radiometer Irradiance Monitor (ACRIM) III instrument, the ACRIMSAT spacecraft provides long-term, precise measurements of the total amount of the Sun's energy that falls on our planet's surface, oceans and atmosphere. ACRIM I was the first instrument to clearly show that the energy from the Sun is not a constant value but instead varies over time. These energy changes are small but significant, and they cycle approximately every 11 years. ACRIMSAT data is vital to helping scientists build more accurate climate models. (Launched: 1999)

#### **Landsat 7**

<http://landsat.gsfc.nasa.gov/main/education.html>

The Landsat 7 satellite is acquiring remotely-sensed images of land surface and coastal regions for global change research, regional environmental change studies, national security uses and other civil and commercial

purposes. The Landsat 7 data set will provide the first high-resolution view of both seasonal and interannual changes in the terrestrial environment. **CONTACT:** Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Phone:** 301-614-6457, **Email:** [stockman@core2.gsfc.nasa.gov](mailto:stockman@core2.gsfc.nasa.gov). (Launched: 1999)

#### **SeaWinds on QuikSCAT**

<http://winds.jpl.nasa.gov/education>

The SeaWinds instrument on the QuikSCAT satellite is a "quick recovery" effort to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT) when the satellite lost power in June of 1997. SeaWinds is a specialized microwave radar that measures near-surface wind speed and direction over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** [pcfalcon@pop.jpl.nasa.gov](mailto:pcfalcon@pop.jpl.nasa.gov). (Launched: 1999)

#### **Terra**

<http://terra.nasa.gov>

Terra, the flagship satellite of NASA's Earth Observing System, is collecting what will ultimately become a new, 15-year global data set on the state of the land, oceans and atmosphere. Data from this mission are used in many research and commercial applications. **CONTACT:** David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** [dherring@climate.gsfc.nasa.gov](mailto:dherring@climate.gsfc.nasa.gov). (Launched: 1999)

#### **EO-1**

<http://eo1.gsfc.nasa.gov/Education/eo1Education.html>

Earth Observing-1 (EO-1) is the first flight of NASA's New Millennium Program (NMP). Its mission is to validate technologies that will reduce the cost and increase capabilities of upcoming land-imaging missions. As a result of EO-1, future spacecraft will be an order of magnitude smaller and lighter than current versions. **CONTACT:** Joseph Young, EO-1 Mission Technology Transfer Manager, NASA Goddard Space Flight Center, **Phone:** 301-286-8146, **Email:** [joseph.p.young.1@gsfc.nasa.gov](mailto:joseph.p.young.1@gsfc.nasa.gov). (Launched: 2000)

#### **Jason-1**

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, Jason-1 is a follow-on mission to TOPEX/Poseidon. See TOPEX/Poseidon (1992 launch) listing on p. 18 for additional details. (Launched: 2001)



**SAGE III/METEOR-3M**

<http://www-sage3.larc.nasa.gov>

The Stratospheric Aerosol and Gas Experiment (SAGE) III mission on the Russian Meteor-3M spacecraft seeks to enhance our understanding of natural and human-derived atmospheric processes by providing high-latitude, long-term measurements of the vertical structure of aerosols, ozone, water vapor and other important trace gases in the upper troposphere and stratosphere. **CONTACT:** David Woods, NASA Langley Research Center, Hampton, VA 23681, **Email:** d.c.woods@larc.nasa.gov. (Launched: 2001)

**Aqua**

<http://aqua.nasa.gov>

Latin for "water," Aqua is named for the large amount of information the mission is collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures. **CONTACTS:** Claire Parkinson, Code 971, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-5715, **Email:** claire.l.parkinson@nasa.gov; Steve Graham, Code 900, NASA Goddard Space Flight Center, **Phone:** 301-614-5561, **Email:** steven.m.graham.2@gsfc.nasa.gov. (Launched: 2002)

**GRACE**

<http://www.csr.utexas.edu/grace/education>

The second of the Pathfinder missions, the Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system to measure the Earth's gravity field and its variability over time. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to the Earth's poles. **CONTACT:** **Email:** grace\_edu@tsgc.utexas.edu. (Launched: 2002)

**SeaWinds on ADEOS II**

<http://winds.jpl.nasa.gov/education>

The Advanced Earth Observing Satellite (ADEOS) II is a joint mission with the National Space Development Agency of Japan (NASDA). The SeaWinds scatterometer is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet

Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 2002)

**ICESat**

<http://icesat.gsfc.nasa.gov/publicoutreach.html>

The Ice, Cloud and Land Elevation Satellite (ICESat) operates the Geoscience Laser Altimeter System (GLAS). GLAS is accurately measuring the elevation of the Earth's ice sheets, clouds and land. Data is available from the National Snow and Ice Data Center (<http://nsidc.org/daac/icesat>). **CONTACT:** **Email:** webmaster@icesat0.gsfc.nasa.gov. (Launched: 2003)

**SORCE**

[http://lasp.colorado.edu/sorce/edu\\_outreach.html](http://lasp.colorado.edu/sorce/edu_outreach.html)

The Solar Radiation and Climate Experiment (SORCE) mission is providing state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared and total solar radiation. The measurements provided by SORCE specifically address long-term climate change, natural variability and enhanced climate prediction, as well as atmospheric ozone and UV-B radiation. These measurements are critical to studies of the Sun and its effect on the Earth system. **CONTACT:** Gary Rottman, Laboratory for Atmospheric and Space Physics, Campus Box 590, University of Colorado, Boulder, CO 80309-0590, **Phone:** 303-492-8324, **Email:** gary.rottman@lasp.colorado.edu. (Launched: 2003)

**Aura**

<http://aura.gsfc.nasa.gov/outreach>

Aura will study the Earth's ozone, air quality and climate. The mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere. **CONTACT:** Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Email:** stockman@core2.gsfc.nasa.gov. (Scheduled launch: 2004)

**GIFTS**

<http://tellus.ssec.wisc.edu/outreach/gifts/gifts.htm>

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will make revolutionary advances in weather observations and potentially improve weather forecasts by making vertical and horizontal measurements of winds, water vapor and temperature in the Earth's atmosphere from a geosynchronous orbit. **CONTACT:** Arlene Levine, NASA Langley Research Center, Hampton, VA 23681-0001, **Phone:** 757-864-3318, **Email:** a.s.levine@larc.nasa.gov. (Scheduled launch: 2005)



**CALIPSO**

<http://www-calipso.larc.nasa.gov/outreach>

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite will produce the first global three-dimensional view of aerosols and clouds. It will improve our understanding of the role aerosols and clouds play in the processes that govern climate responses and feedbacks, and improve the representation of aerosols and clouds in models, leading to more accurate predictions of climate change.

Accurate climate model predictions will provide international and national leaders with reliable information to make more informed policy decisions about global climate change. CALIPSO will fly in formation with Cloudsat (see next listing) and other satellites.

**CONTACTS:** Dianne Robinson, Outreach Director for CALIPSO, Interdisciplinary Science Center (ISC), Hampton University, **Email:** [dianne.robinson@hamptonu.edu](mailto:dianne.robinson@hamptonu.edu); Barbara Maggi, Assistant Outreach Director for CALIPSO, Center for Atmospheric Sciences (CAS), Hampton University, **Email:** [barbara.maggi@hamptonu.edu](mailto:barbara.maggi@hamptonu.edu). (Scheduled launch: 2005)

**CloudSat**

<http://cloudsat.atmos.colostate.edu/outreach>

CloudSat will provide vertical profiling from space of the full range of clouds, from thin cirrus to thick, precipitating convective clouds. It will also provide the first quantitative estimates of ice in clouds. The mission will fill a critical gap in the investigation of feedback mechanisms linking clouds to climate. CloudSat will orbit in formation as part of a constellation of satellites including Aqua, Aura and CALIPSO. One of the unique features that CloudSat brings to this constellation is the ability to fly a precise orbit, enabling the footprint of the CloudSat radar to be overlapped with that of the CALIPSO lidar, as well as with other instruments in the constellation. The precision of this overlap creates a unique multi-satellite observing system for studying atmospheric processes essential to the hydrological cycle. **CONTACT:** Debra Krumm, Outreach Coordinator, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371, **Phone:** 970-491-8790, **Email:** [dkrumm@atmos.colostate.edu](mailto:dkrumm@atmos.colostate.edu). (Scheduled launch: 2005.)

**PUMAS (Practical Uses of Math and Science)**

<http://pumas.jpl.nasa.gov>

PUMAS is the online journal of one-page examples illustrating how math and science concepts are actually used in everyday life. PUMAS examples may be activities, anecdotes, descriptions of neat ideas, formal exercises, puzzles or demonstrations, written primarily by scientists. They are intended mainly to help K–12 teachers enrich their presentation of science and math in the classroom. Teachers can search the PUMAS collection based on curriculum topic, grade level, and subject. They can select relevant examples, and develop ideas of their own about how to integrate the material into their lesson plans.

**Recommended for: K–12 teachers.**